

ORIGINAL RESEARCH ARTICLE

Pregnancy related complications due to obesity and gestational diabetes mellitus among women in Saudi Arabia

DOI: 10.29063/ajrh2022/v26i2.4

Aqeela Zahra¹, Sehar-un-Nisa Hassan^{2*}, Nuzhat Parveen^{3*}, Naveed Iqbal⁴ and Asma Batool⁵

Department of Family and Community Medicine, College of Medicine, University of Ha'il, Saudi Arabia¹; Department of Public Health, College of Public Health and Health Informatics, University of Ha'il, Saudi Arabia²; Department of Obstetrics and Gynecology, College of Medicine, University of Ha'il, Saudi Arabia^{3,4}; Maternity and Children Hospital, Ha'il, Saudi Arabia⁵

***For Correspondence:** Email: s.nisa@uoh.edu.sa; n.parveen@uoh.edu.sa

Abstract

Gestational Diabetes mellitus (GDM) is one of the major maternal health problems in Middle East countries. In Saudi Arabia, the prevalence rates of GDM fall in the range of 16.2% to 24.2%. The study determined the antenatal complications and adverse pregnancy outcomes associated with GDM among a sample of Obese/GDM and Non-Obese/GDM women. A record based retrospective study was conducted including females who received obstetric care in a tertiary care hospital in Ha'il city of Saudi Arabia from December 2020 to June 2021. We gathered data from the medical records of 376 pregnant females who were registered and delivered at Maternity and Children Hospital (MCH). Multinomial regression analysis was applied to determine independent association of GDM and Obesity with pre-postnatal health outcomes. Out of 376 pregnant women 29.2% were identified as (Non-Obese/Non-GDM); 37.1% of women as having both conditions (GDM/Obesity); 19.2% as (Non-Obese/GDM) and 14.1% as (Obese/Non-GDM). The proportion of underweight and overweight babies were high in women with both conditions (Obese/GDM). Findings from our regression analysis demonstrated that Non-Obese/GDM women were 2.7 times more likely to have high child birthweight ($p<0.001$) when compared to Non-Obese/Non-GDM. Obese/GDM women were more likely to have low Appearance, Pulse, Grimace, Activity, and Respiration (APGAR) scores ($p<0.001$) and increase neonatal intensive care unit (NICU) admissions ($p<0.01$). Healthcare policy makers and professionals should revisit gaps in existing obstetrical care to prevent adverse impact on women and newborn health. Non-Obese women at risk of GDM should also be given due attention for early screening, timely diagnosis, and appropriate pre-postnatal care. (*Afr J Reprod Health* 2022; 26[2]: 38-46).

Keywords: Gestational diabetes, obesity, obstetric care, antenatal health, birthweight, post-natal care

Résumé

Le diabète gestationnel est l'un des principaux problèmes de santé maternelle dans les pays du Moyen-Orient. En Arabie saoudite, les taux de prévalence du DG se situent entre 16,2 % et 24,2 %. L'étude a déterminé les complications prénatales et les issues de grossesse indésirables associées au DG parmi un échantillon de femmes obèses/DG et non obèses/DG. Une étude rétrospective basée sur les dossiers a été menée auprès de femmes ayant reçu des soins obstétricaux dans un hôpital de soins tertiaires de la ville de Ha'il en Arabie saoudite de décembre 2020 à juin 2021. Nous avons recueilli des données à partir des dossiers médicaux de 376 femmes enceintes qui ont été enregistrées et ont accouché à Hôpital de la maternité et de l'enfance (MCH). Une analyse de régression multinomiale a été appliquée pour déterminer l'association indépendante du DG et de l'obésité avec les résultats de santé pré-postnatals. Sur 376 femmes enceintes, 29,2 % ont été identifiées comme (non obèses/non DG) ; 37,1 % des femmes ont les deux conditions (GDM/Obésité) ; 19,2 % en tant que (Non-Obèse/GDM) et 14,1 % en tant que (Obèse/Non-GDM). La proportion de bébés en insuffisance pondérale et en surpoids était élevée chez les femmes atteintes des deux affections (obésité/DSG). Les résultats de notre analyse de régression ont démontré que les femmes non obèses/GDM étaient 2,7 fois plus susceptibles d'avoir un poids élevé à la naissance ($p<0,001$) par rapport aux femmes non obèses/non GDM. Les femmes obèses/GDM étaient plus susceptibles d'avoir de faibles scores d'apparence, de pouls, de grimace, d'activité et de respiration (APGAR) ($p<0,001$) et d'augmenter les admissions en unité néonatale de soins intensifs (USIN) ($p<0,01$). Les décideurs politiques et les professionnels de la santé devraient revoir les lacunes dans les soins obstétricaux existants pour prévenir les effets néfastes sur la santé des femmes et des nouveau-nés. Les femmes non obèses à risque de DG doivent également faire l'objet d'une attention particulière en matière de dépistage précoce, de diagnostic rapide et de soins pré-postnatals appropriés. (*Afr J Reprod Health* 2022; 26[2]: 38-46).

Mots-clés: Diabète gestationnel, obésité, soins obstétricaux, santé prénatale, poids de naissance, soins postnatals

Introduction

Diabetes Mellitus (DM) is a state of persistent hyperglycemia due to absolute (Type 1 DM) or relative deficiency of insulin or metabolic insulin insensitivity at organ level (Type 2 DM)¹. Diabetes mellitus encountered in pregnant women can be pre-existing or gestational. Gestational diabetes mellitus (GDM) is the persistent maternal hyperglycemic state first time recognized during second or third trimester of pregnancy in women who were previously non-diabetic before conception¹. There is no consistent data to show the global prevalence of gestational diabetes due to the variety of diagnostic tests used variably throughout the world. However, a meta-analysis on the prevalence of gestational diabetes mellitus in Asia showed a mean prevalence of 11.5 % in Asia. Saudi Arabia falls into the high prevalent countries by having 22.9 %². Local studies performed in Saudi Arabia also reflected a high prevalence of GDM, 16.2% and by Riyadh Mother and Baby Cohort Study (RAHMA) is 24.2%^{3,4}.

Many factors increase the number of pregnancies identified as GDM. One is global increase in obesity and physical inactivity and the other is changing trends of having late marriages and conceptions at higher reproductive age². World Health Organization (WHO) data report for non-communicable diseases published in 2018 indicated that there are rising trends of obesity over the past two decades in Saudi Arabia⁵. Physical inactivity in adults is a pronounced problem and percentage of females affected is more as compared to males (64:44) as of 2016 statistics⁵. According to these statistics, 41 % of females in Saudi Arabia were categorized as obese. According to some estimates, Saudi Arabia is among top 20 countries where obesity burdens up the pregnancies⁶. A retrospective analysis of six years' of data published from Jeddah, Saudi Arabia showed that 24.5 % of present women were found to be obese⁷. Pregnancies affected by diabetes are at greater risk of perinatal complications in the mother and child. Furthermore, diabetic obese women are at higher risk of spontaneous abortions, poor weight gain during pregnancy and can develop pregnancy induced hypertension, pre-eclampsia, antepartum hemorrhage, interventions during labor and cesarean births⁸⁻⁹. Maternal obesity is also

found to be an independent risk for development of these complications¹⁰. The fetuses of these mother face increased exposure risk of hyper-glycaemia, congenital abnormalities, accelerated growth (large for gestational age), and stillbirths^{8, 11-12}. Additionally, diabetes during pregnancy put the mother at increased risk of premature terminations of pregnancies because of resulting antenatal complications that further add on the burden of prematurity¹³.

Studies in the past ten years from Saudi Arabia were more focused on obese women with GDM, which is undoubtedly a significant issue^{3, 7}. A recent study concluded that maternal obesity is a greater risk factor than GDM for poor perinatal outcomes and particularly for child birthweight¹⁴. These inferences are helpful to support at risk women, nonetheless, screening procedures and preventive interventions need to pay equal attention to non-obese women at risk of GDM. Keeping in view, some previous literature points out that neither obesity nor GDM independently increase the risk for birth weight¹⁵. In our view, it is important to re-evaluate such contradictory interpretations by collecting more evidence so that both non-obese women with GDM or obese women without GDM be not ignored or catch less attention based upon general conclusions.

This study aims to find out the independent as well as synergetic effect of GDM and obesity on antenatal complications and adverse pregnancy outcomes among Saudi women seeking obstetric healthcare in tertiary hospital in Ha'il city of Saudi Arabia. Such analysis will also be helpful to identify current gaps in screening and obstetrical care of women who present with risk of GDM. Additionally, study findings will be useful to reflect on current gaps and improve the current approach and practices to improve maternal and child health services.

Methods

Study design

A retrospective study was conducted including 376 pregnant females who were treated and delivered at maternity and children hospital (MCH) in Ha'il, Saudi Arabia. Data for this study was collected from medical records of women who already delivered

between December 2020 to June 2021. Saudi women with a singleton pregnancy who were otherwise healthy and who registered and delivered at MCH were included in the study. Pregnant women who were non-Saudi or had any other medical and obstetrical condition were excluded from the study. All women had regular antenatal checkups by the obstetrician. After the patients delivered, all the required information was collected from the medical records. Informed consent was taken from each patient after clarifying the purpose of study.

Study variables

Independent variables

Based on the GDM and obesity status women were divided into four groups; Group 1: (Non-GDM/Non-obese); Group 2: (GDM/Non-obese); Group 3: (Obese/Non-GDM); and Group 4: (Obese/GDM). Body mass index was calculated by weight/height squared (kg/m^2). Based on criterion by WHO, females with $\text{BMI} \geq 30.0 \text{ kg/m}^2$ were considered obese¹⁶. All participants were screened for GDM by oral glucose tolerance test (OGTT), using 75-gram glucose load. Plasma glucose levels were measured at fasting and 2-hours after the glucose intake. GDM was diagnosed if fasting plasma glucose ranged between 5.1 to 6.9 mmol/l or 2-hour plasma glucose level was 8.5 to 11.0 mmol/l¹⁷.

Dependent variables

The above four groups were compared for antenatal complications during pregnancy and adverse pregnancy outcomes. Antenatal complications including polyhydramnios, pregnancy induced hypertension (PIH), pre-eclampsia, preterm labor and intra uterine fetal demise (IUFD) were documented as categorical variables ('Yes' or 'No'). Fetal birthweight was noted in kilograms and used as continuous variable for mean differences. The fetal birthweight was also analyzed by categorizing fetal birthweight as 'Underweight <2.5 kg'; 'Normal weight 2.5-4 kg' and 'Overweight >4 kg' (WHO Child Growth Standards)¹⁸. Other adverse pregnancy outcomes including cesarean delivery, low APGAR score and NICU admissions were also

recorded as categories of 'Yes' or 'No'. APGAR score of 7 or less was considered as low.

Statistical analysis

Data analysis was done by using Statistical Package for Social Sciences (SPSS version 23; SPSS Inc., Chicago, IL). Descriptive analysis was performed to analyze the frequency and percentages of four groups. Chi-square test was performed to compare the proportions of categorical variables between the obesity and GDM groups. To compare the significance of difference among means of continuous variables, one-way ANOVA was used. Post-hoc analysis was conducted to identify whether mean birthweights for (Non-Obese/GDM) are significantly different from other group means. Multinomial logistic regression was applied to determine the vulnerability of (GDM/Obese) group for adverse pregnancy outcomes. Group 1 (Non-Obese/Non-GDM) was taken as the reference group. P-value <0.05 was taken statistically significant.

Results

Among 376 females, 51.2% had obesity and 56.8% were diagnosed with GDM during pregnancy. Figure 1 shows the distribution of pregnant females according to the four GDM and obesity groups. In our study sample, 37.1% of women had both GDM and obesity, followed by 29.2% of non-obese and non-GDM group. 19.4% were non-obese but with GDM and 14.1% were obese but did not have GDM. Figure 2 shows that mean birth weight differed slightly across the four groups. Highest mean birth weight was recorded among (Obese/GDM) group followed by (Obese/Non-GDM) and (Non-obese GDM) group respectively.

Table 1 demonstrates bivariate analysis of distribution of maternal characteristics, antenatal complications, and pregnancy outcomes among all four groups. Analysis showed that mothers in GDM obese group had highest mean age (36.2 years) and BMI (39 kg/m^2) as compared to other three groups. Overall, (n=79; 21%) of women in this sample of pregnant women give birth to either underweight or overweight baby. Analysis demonstrate that proportion of 'overweight' babies was highest for 'Obese/GDM' (18.9%) followed by 'Non-Obese/GDM' (5.6%) which is higher in comparison

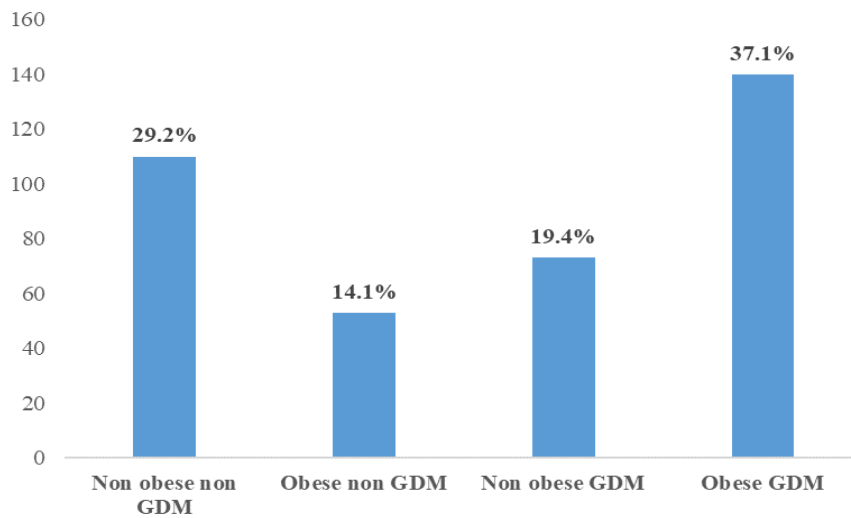


Figure 1: Distribution percentages of the pregnant women by obesity and GDM status (N=376)

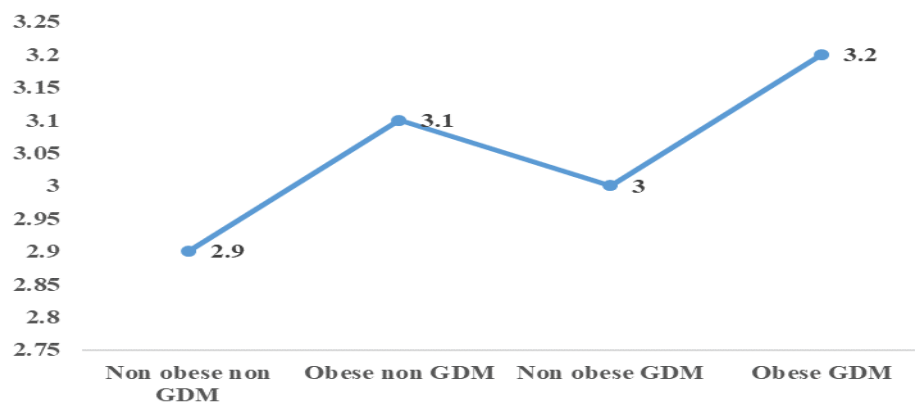


Figure 2: Mean birth weight of the newborn by GDM/Obesity groups (N=376)

to 'Obese/GDM' women (1.1%). Proportion of antenatal complications including PIH, pre-eclampsia and IUFD was also significantly high among GDM obese group followed by non-obese GDM group. Adverse pregnancy outcomes also followed the same pattern with highest rates of cesarean delivery (28.2%), poor APGAR at birth (33.5%) and NICU admissions (32.4%) in mothers of 'Obese/GDM' group followed by 'Non-obese/GDM' group.

The Analysis of Variance (ANOVA) demonstrate that between group differences were significant at [$F=4.8$, $DF=3$; $p<0.05$]. The post-hoc analysis by applying Dunnett test (2-sided) where (Non-Obese/Non-GDM) was taken as control group demonstrated that the mean value of

birthweights was significantly different only for [Obese/GDM] ($p<0.01$, 95% C.I. = [0.124-0.583]). (Table 2)

Table 3 shows the association of 'Obesity/GDM' with adverse pregnancy outcomes by multinomial logistic regression. 'Non-Obese/GDM' group had significantly higher birthweights with OR of 2.78 and had higher risk of 'low APGAR' score (OR=25.39) as compared to group 1 i.e. control group (Non-obese/Non-GDM). Group 4 (Obese/GDM group) had significantly higher birthweights (OR=4.6) and 3.37 times higher risk of cesarean delivery. These women also had higher risk of low APGAR scores (OR=28.9) and increase NICU admissions (OR=1.46). Obese/non-GDM group did not show statistically significant

Table 1: Maternal characteristics, antenatal complications, and pregnancy outcomes of the four groups by GDM and Obesity conditions (N=376)

Variables	Non-Obese/ GDM (n=110)	Non- Obese/Non- GDM (n=53)	Non-Obese/ GDM (n=73)	Obese/ GDM (n=140)	p-value significance
Maternal characteristics (Mean)					
Age (years)	30.9	33.9	32.6	36.2	0.001***
BMI (kg/m ²)	25.1	33.6	26.1	39.1	0.01**
Antenatal Complications Numbers (%)					
Polyhydramnios	12 (3.2%)	5 (1.3%)	9 (2.4%)	29 (7.7%)	0.078(ns)
PIH ¹	9 (2.4%)	10 (2.7%)	16 (4.3%)	31 (8.2%)	0.021*
Pre-eclampsia	9 (2.4%)	7 (1.9%)	16 (4.3%)	30 (8%)	0.01**
IUFD ²	1(0.3%)	1 (0.3%)	7 (1.9%)	10 (2.7%)	0.02*
Preterm labor	23 (6.1%)	7 (1.9%)	9 (2.4%)	25 (6.6%)	0.41(ns)
Pregnancy outcomes					
Birthweight categories					
Underweight	15 (13.6%)	10 (18.9%)	13 (18.1%)	15 (10.8%)	0.01**
Normal weight	92 (83.6%)	42 (79.2%)	55 (76.4%)	106(76.3%)	
Overweight	3 (2.7%)	1 (1.9%)	4 (5.6%)	18 (12.9%)	
Caesarian delivery	41 (10.9%)	24 (6.4%)	51 (13.6%)	106(28.2%)	0.01**
Numbers					
Low APGAR Score	5 (1.3%)	3 (0.8%)	66 (17.6%)	126(33.5%)	0.01**
Numbers					
NICU ³ Admission	22 (5.9%)	10 (2.7%)	64(17.0%)	122(32.4%)	0.01**
Numbers					

¹Pregnancy Induced Hypertension. ²Intrauterine Fetal Demise. ³Neonatal Intensive Care Unit.

p-value significance***p<0.001; **p<0.01; *p<0.05

Table 2: Post-hoc analysis to determine between group differences in mean birthweight (N= 376)

(I) GROUPS	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Obese/Non-GDM	0.20	0.12	-0.09	0.50
Non-Obese/GDM	0.08	0.11	-0.18	0.35
Obese/GDM	0.35***	0.09	0.12	0.58

(J) Non-Obese/Non-GDM was taken as a reference group; p-value significance***p<0.001; **p<0.01; *p<0.05

Table 3: Association of GDM and obesity with adverse pregnancy outcomes (N=376)

GDM Groups*	Obesity	Adverse Outcomes	Pregnancy B	Std. Error	Exp(B)	95% Confidence Interval for Exp(B)	Lower Bound	Upper Bound
Group 2 Obese/Non-GDM		Birth weight	0.48	0.26	1.62	0.96	2.71	
		Cesarean delivery	0.40	0.34	1.49	0.75	2.94	
		Low APGAR score	0.50	0.87	1.66	0.30	9.20	
		NICU admission	0.13	0.51	1.14	0.42	3.08	
Group 3 Non-Obese/GDM		Birth weight	1.02	0.29	2.78***	1.57	4.91	
		Cesarean delivery	0.76	0.48	2.15	0.83	5.58	
		Low APGAR score	5.54	0.93	25.39***	20.78	30.38	
		NICU admission	0.41	0.81	1.50	0.30	7.35	
Group 4 Obese/GDM		Birth weight	1.53	0.29	4.63***	2.59	8.28	
		Cesarean delivery	1.21	0.46	3.37***	1.36	8.33	
		Low APGAR score	5.59	0.88	28.94***	18.53	35.58	
		NICU admission	0.38	0.74	1.46***	0.33	6.38	

*Group1, Non-obese, non GDM was taken as reference group

***p value calculated by multinomial logistic regression, significant at <0.05

high risk for these adverse pre-natal and post-natal health outcomes when compared to the control group (Non-Obese/Non-GDM).

Discussion

Maternal obesity and GDM have been recurrently reported as risk factors for child and maternal health outcomes. In the past few years, the public health literature put more emphasis on obesity and its adverse outcomes on women's health in general and specific outcomes on maternal and child health¹⁹. The rationale for conducting our analysis were twofold. Firstly, to examine the pre-natal and post-natal health outcomes for pregnant women seeking obstetric care in a tertiary care hospital in Ha'il city of Saudi Arabia. This examination is helpful to identify existing gaps in obstetric care for women with obesity, with GDM or with both conditions. Secondly, we aimed to re-check the inference drawn from a recent research study, which concluded that maternal obesity is a greater risk factor than GDM for poor perinatal outcomes and particularly for child birthweight¹⁴. However, some research findings contradict these inferences, which reported that GDM is independently associated with macrosomia and another study reported that maternal weight is not an independent risk factor for macrosomia and other indicators of poor antenatal health^{15, 19}.

In the context of Saudi Arabia and some other countries, the screening for GDM concentrates more on over-weight and obese women based upon previous research evidences and obstetric care also prioritize care for obese women, which is indispensable²⁰⁻²². Simultaneously, to prevent any disparities in the identification and obstetrical care of women with GDM, it is important to re-evaluate the interpretation of previous study findings. 'Non-Obese' patients with 'GDM' should not be ignored or catch less attention based upon unidirectional conclusions. We took a sample of 376 women to determine independent association of GDM with poor perinatal outcomes such as underweight child or overweight child at the time of birth. Women were categorized in the same manner as 'Non-obese and Non-GDM', "Obese but without GDM"; "Non-obese but with GDM" and women with both conditions "Obesity and GDM"¹⁴.

We found that mean child birthweights for all group fall in normal birthweight range i.e. (≥ 2.5 kg < 4.0 kg) as per the criteria by World Health Organization (WHO)²³⁻²⁴. Our findings show that "Non-obese/Non-GDM" women had lowest mean values on birthweight in comparison to other groups. The post-hoc analysis demonstrated that condition of "Obese/GDM" and condition of "Non-Obese/Non-GDM" demonstrate significant mean differences. However, mean differences of birthweights between "Obese/Non-GDM" and "Non-Obese/GDM" were statistically non-significant. These findings suggest though 'Obesity' with 'GDM' together significantly increase the risk for increased birthweight however, 'Non-Obese/GDM' group of women and 'Obese/GDM' group were not significantly different in term of birthweights. Since the birthweights were calculated as mean scores for each group which can be influenced by very high and very low mean score thus, we also inspected the differences by categorizing the child birthweight as 'Underweight'; 'Normal weight' and 'Overweight'. Both low and high birthweights are considered as adverse outcomes for newborn and later child health thus focus of any analysis in relation to impact of obesity and GDM on birthweight should consider both aspects²⁵. This piece has been ignored by previous research^{14, 26}. Our findings validate that 'Obesity' and "GDM" independently associate with giving birth to 'underweight child'. Furthermore, analysis demonstrate that proportion of 'overweight' babies was higher for 'Non-Obese/GDM' women in comparison to 'Obese/GDM' women. These findings imply that GDM independently increase the chance for macrosomia and there is need for close clinical follow up of women with 'GDM' and even without 'Obesity' to prevent adverse perinatal outcomes.

Findings from multinomial regression analysis demonstrated that 'Non-Obese/GDM' group of women were 2.7 times more likely to have increased child birthweight when compared to control group i.e. 'Non-Obese/Non-GDM'. However, it demonstrated non-significant association for 'Obese/Non-GDM' group. These results emphasize that screening for GDM should be done more extensive by including other indicators to ensure non-obese women are not missed in screening for GDM. This inference is consistent

with another study, which suggested that Random Plasma Glucose (RPG) at time of booking is more relevant indicator than BMI for detecting women at elevated risk of GDM. Thus, for early diagnosis of GDM in women without obesity, some significant markers should be highlighted with more focused research²⁷.

With respect to antenatal outcomes and other pregnancy outcomes, our study findings aligns with previous population-based study which supported that “Obese/GDM” women are at highest risk for poor maternal and child health outcomes²⁶. These women were at higher risk for PIH, pre-eclampsia, and IUFD. Regarding pregnancy outcomes cesarean delivery, low Apgar score and NICU admissions were also significantly associated with both conditions of ‘Obese/GDM’. These findings validate the previous evidence and underscore the need for more close antenatal care and medical follow-up of women with both conditions of obesity and GDM^{8, 12}. Our findings thus also point towards the existing gaps in obstetric care of women with GDM as findings demonstrate that overall, (21%) of women give birth to either underweight or overweight baby and this risk was further increased for women with GDM and obesity. Findings imply the need for timely interventions, which can reduce the extent and severity of the problem, like educating the women about weight management, physical activity time, avoidance of obesity, healthy weight gain during pregnancy. Effective screening procedures and support of healthcare providers in obstetric care can result in improved maternal and child health and reduced burden on maternal health care services.

Ethical approval

This study is approved by Research Ethics Committee of University of Ha'il (UoH) with Protocol [Nr.20455/5/42] and abide by ethical principles including informed consent, confidentiality, beneficence, and non-maleficence.

Conclusion

Obese/GDM women and Non-Obese GDM women both face significant repercussions on their antenatal health and pregnancy outcomes including underweight or overweight newborn baby, PIH, pre-

eclampsia, IUFD and cesarean section. Despite some of the limitations of study i.e., a small sample of pregnant women, recruited from one tertiary care hospital and data was collected on limited maternal and child health indicators; the current study provides ample evidence about independent and combined impact of GDM and Obesity on health of pregnant women seeking obstetric care. Findings imply the need to improve the screening procedures as well as expand the obstetrical healthcare to fill the existing gaps. These can be achieved through inclusive approach where women with obesity and without obesity should be timely screened on various markers for early identification of GDM. Additionally, a regular and close medical follow-up of women diagnosed with GDM should be done to prevent its adverse outcome on maternal and child health. These measures will also effectively reduce the burden on healthcare services by preventing unnecessary NICU admissions and cesarean section. Besides preventive interventions like educating the women about impact of GDM on their health and child health, avoidance of obesity and regular engagement in physical activity during pregnancy are helpful to sustain good maternal health for wider populations.

Conflict of interest

None.

Authors' contributions

All the authors contributed and approved the final study.

Acknowledgments

We would like to thank Maternity and Children Hospital (MCH) in Hail, Saudi Arabia, for their support in accessing medical record and retrieval of data on study variables. We would like to thank all pregnant women who gave consent to participate in the study.

Funding

This research was funded by Scientific Research Deanship at the University of Ha'il (UoH), Kingdom of Saudi Arabia through, grant number RG-20092.

References

1. American Diabetes Association Diabetes Care 2021 Jan; 44(Supplement 1): S15-S33. <https://doi.org/10.2337/dc21-S002>.
2. Lee KW, Ching SM, Ramachandran V, Yee A, Hoo FK, Chia YC, Wan Sulaiman WA, Suppiah S, Mohamed MH and Veettil SK. Prevalence and risk factors of gestational diabetes mellitus in Asia: a systematic review and meta-analysis. BMC Pregnancy Childbirth. 2018; 18(1):494. <https://doi.org/10.1186/s12884-018-2131-4>.
3. Alfadhli EM, Osman EN, Basri TH, Mansuri NS, Youssef MH, Assaaedi SA and Aljohani BA. Gestational diabetes among Saudi women: prevalence, risk factors and pregnancy outcomes. Ann Saudi Med. 2015;35(3):222–30.
4. Wahabi H, Fayed A, Esmaeil S, Mamdouh H and Kotb R. Prevalence and Complications of Pregestational and Gestational Diabetes in Saudi Women: Analysis from Riyadh Mother and Baby Cohort Study (RAHMA). Saisho Y, editor. Biomed Res Int [Internet]. 2017; Article ID 6878263. <https://doi.org/10.1155/2017/6878263>.
5. World Health Organization (WHO). Noncommunicable diseases country profiles 2018. [Internet]. License: CC BY-NC-SA 3.0 IGO; 2018. Available from: <https://apps.who.int/iris/handle/10665/274512>.
6. Chen C, Xu X and Yan Y. Estimated global overweight and obesity burden in pregnant women based on panel data model. PLoS One. 2018;13(8):e0202183.
7. Fallatah AM, AlNoury A, Fallatah EM, Nassibi KM, Babatin H, Alghamdi OA, Tarabai BY and Abduljabbar HS. Obesity Among Pregnant Women in Saudi Arabia: A Retrospective Single-Center Medical Record Review. Cureus. 2021;13(2):e13454.
8. Grabowska K, Stapińska-Syniec A, Saletra A, Jarmużek P and Bomba-Opoń D. Labour in women with gestational diabetes mellitus. Ginekolog Pol. 2017;88(2):81–6.
9. Wojtyła C, Stanirowski P, Gutaj P, Ciebia M and Wojtyła A. Perinatal Outcomes in a Population of Diabetic and Obese Pregnant Women-The Results of the Polish National Survey. Int J Environ Res Public Health. 2021;18(2):560. doi: 10.3390/ijerph18020560.
10. Shin D and Song WO. Prepregnancy body mass index is an independent risk factor for gestational hypertension, gestational diabetes, preterm labor, and small- and large-for-gestational-age infants. J Matern Fetal Neonatal Med. 2015;28(14):1679–86.
11. Merc MD, Lučovnik M, Bregar AT, Verdenik I, Tul N and Blickstein I. Stillbirths in women with pre-gravid obesity. J Perinat Med. 2019;47(3):319–22.
12. Stogianni A, Lendahls L, Landin-Olsson M and Thunander M. Obstetric and perinatal outcomes in pregnancies complicated by diabetes, and control pregnancies, in Kronoberg, Sweden. BMC Pregnancy Childbirth. 2019;19(1):159.
13. Kong L, Nilsson IAK, Gissler M and Lavebratt C. Associations of Maternal Diabetes and Body Mass Index With Offspring Birth Weight and Prematurity. JAMA Pediatr. 2019;173(4):371–8. Available from: <https://doi.org/10.1001/jamapediatrics.2018.5541>
14. Alfadhli EM. Maternal obesity influences Birth Weight more than gestational Diabetes author. BMC Pregnancy Childbirth. 2021;21(1):1–7.
15. Ott R, Stupin JH, Loui A, Eilers E, Melchior K, Rancourt RC, Schellong K, Ziska T, Dudenhausen JW, Henrich W and Plagemann A. Maternal overweight is not an independent risk factor for increased birth weight, leptin and insulin in newborns of gestational diabetic women: observations from the prospective ‘EaCH’ cohort study. BMC Pregnancy Childbirth. 2018;18(1):250. Available from: <https://doi.org/10.1186/s12884-018-1889-8>
16. World Health Organization (WHO). Obesity and overweight. WHO. 2020. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
17. World Health Organization (WHO). Diagnostic criteria and classification of hyper-glycaemia first detected in pregnancy. WHO. 2013. Available from: <https://apps.who.int/iris/handle/10665/85975>.
18. World Health Organization. Child Growth Standards. WHO. 2020. Available from: <https://www.who.int/tools/child-growth-standards/standards/weight-for-age>
19. He X-J, Qin F, Hu C-L, Zhu M, Tian C-Q and Li L. Is gestational diabetes mellitus an independent risk factor for macrosomia: a meta-analysis? Arch Gynecol Obstet. 2015;291(4):729–35. Available from: <https://doi.org/10.1007/s00404-014-3545-5>
20. Al Rowaily MA and Abolfotouh MA. Predictors of gestational diabetes mellitus in a high parity community in Saudi Arabia. EMHJ - Eastern Mediterranean Health Journal. 2010;16 (6), 636-641. Available from: <https://apps.who.int/iris/handle/10665/117931>
21. Harper LM, Jauk V, Longo S, Biggio JR, Szychowski JM and Tita AT. Early gestational diabetes screening in obese women: a randomized controlled trial. Am J Obstet Gynecol. 2020;222(5):495-e1.
22. Athukorala C, Rumbold AR, Willson KJ and Crowther CA. The risk of adverse pregnancy outcomes in women who are overweight or obese. BMC Pregnancy Childbirth. 2010;10(1):1–8.
23. World Health Organization WHO. The International Statistical Classification of Diseases and Health Related Problems ICD-10: Tenth Revision. Volume 1: Tabular List. Vol. 1. WHO. 2004.
24. World Health Organization. (WHO). International statistical classification of diseases and related health problems, 10th revision, Fifth edition, 2016. WHO. 2015. <https://apps.who.int/iris/handle/10665/246208>.
25. Lewandowska M. Maternal Obesity and Risk of Low Birth Weight, Fetal Growth Restriction, and Macrosomia: Multiple Analyses. Nutrients. 2021;13(4):1213.
26. Ijäs H, Koivunen S, Raudaskoski T, Kajantie E, Gissler M and Vääräsmäki M. Independent and concomitant associations of gestational diabetes and maternal obesity to perinatal outcome: A register-based study.

Zahra et al.

PLoS One. 2019;14(8):e0221549.

27. Naik R, Karmali D, Nagarsenkar A, Mainath S and Pednekar G. Effect of Pre-pregnancy Maternal Body Mass

Obstetrical care of women with gestation diabetes

Index on Obstetric Outcomes in a Tertiary Care Hospital in Goa, India. J Obstet Gynecol India. 2021;1–6.