Original Article

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Correlation of Placental / Birth Weight Ratio with HbA1c among Healthy Sudanese Pregnant Ladies in Alban-Jaded Teaching Hospital, 2022

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ABSTRACT

Background: The placenta is a life-supporting organ for the growing fetus. Several studies have highlighted the relationship between placental weight and neonatal birth weight; however, the role of glycosylated hemoglobin (HbA1c) has not been addressed. **Aim**: The study aimed to determine the relationship between the placental weight, neonatal birth weight, and HbA1c at term pregnancy in a Sudanese hospital. **Methods**: This was a cross-sectional hospital-based study conducted at Al Ban-Jaded Hospital between November and December 2022. Data, including the gestational age at delivery (in weeks), parity, mode of delivery, fetal birth weight, placental weight, fetal gender, and presence or absence of maternal medical diseases, was obtained from 60 singleton term deliveries who met the inclusion criteria for the study. The tested data was analyzed using SPSS version 25, and t-test was used to compare the statistical significance (P value ≤ 0.05 was considered statistically significant). **Results**: The mean age was 27.02 ± 6.8 years. The mean HbA1C was 5.98% ± 0.39% (5.2%–6.9%). Glycated hemoglobin was elevated (≥5.7%) in majority (46, 76.7%) of pregnancies. The mean placental weight was 290 ± 106 g (100 g–700 g), while the mean birth weight was 3.00 kg ± 0.36 kg (2.3 kg–3.8 kg), and the placental/birth weight ratio was 9.6%. There was a significant positive correlation between neonatal weight and placental weight (r=0.514, P value=0.000). Also, neonatal weight and placental weight had a significant positive correlation with HbA1C (r=0.657, P value=0.000). Placental weight and neonatal birth weight significantly increased with the gestational age of neonates (P value <0.05), with a slight drop noted in term gestation. **Conclusions**: There is a positive correlation between placental weight and birth weight of the neonate in pregnancies with high maternal HbA1C, and placental weight and birth weight were higher than in pregnancies with normal maternal HbA1C.

Keywords: Birth weight, placenta, HbA1C, neonatal, relationship

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INTRODUCTION

The balance between the maternal-placental supply and demand for nutrients, which is directly correlated with uteroplacental blood flow, placental size, and the placenta's capacity for transfer, controls fetal growth.[1] When maternal-placental supply is insufficient to meet demand, the fetus attempts to adapt by altering its body composition and endocrine state, choosing which organs to grow and adopting cardiovascular adaptations.[2] The fetoplacental unit receives more glucose and nutrients when the mother's insulin sensitivity declines with

increasing gestation, as insulin sensitivity is inversely correlated with both placental and fetal fat-free weight.[3]
The complex metabolic and endocrine functions of the placenta are crucial for the development and survival of the fetus in utero. In addition, the weight of the placenta and the fetus are strongly correlated.[4] However, in the human, placental growth exhibits an S-curve regression, whereas fetal growth has an exponential pattern, attaining its maximum size during the third trimester when fetal body fat mass also increases significantly.[5] So, during pregnancy, the ratio of placental-to-fetal weight increases dramatically.[6]
The fetal/placental weight ratio is a reliable indicator of the outcome of the newborn: in normal, intrauterine growth restriction (IUGR), and preterm pregnancies, both high and low fetal/placental weight ratios have been linked to an increased risk of stillbirth and unfavorable neonatal outcomes.[7]
In Sudan, studies investigating gestational diabetes (GDM) are scarce. In 2012, a study on 100 pregnant women found that the prevalence of GDM was 2%.[8] This is because GDM was defined as diabetes mellitus in pregnancy by the Clinical Practice Guidelines and Standards of Care of Diabetes Mellitus in Sudan as late as 2011. This clearly shows that the guidelines in Sudan had been failing to incorporate the latest research in GDM. Based on the prevalence of T2DM in similar populations, the prevalence in this study is at least nine times lower. The only available report in the literature regarding risk factors for GDM in Sudanese pregnant women was conducted by Khattab and his colleagues in 2007.[9]
Sudan exemplifies the problems of data on GDM in the Arab world and worldwide. Despite fine medical schools, a reasonably well developed health care system, there are few data available.[10]
Furthermore, in pregnancies complicated by gestational diabetes, increased placental weight, placental size, and placental weight-to-birth weight ratio have been recorded. Also, an association between placental size and the duration and management of diabetes mellitus was identified.[5]
According to a previous study,11 there was a significant correlation between the placental/fetal weight ratio and glucose concentrations two hours after oral glucose tolerance test (OGTT) in both mild gestational diabetes and impaired gestational glucose intolerance. This suggests that the degree of glucose tolerance may affect the placental/fetal weight ratio.[11]

HbA1c is formed over a period of two -three months and reflects the glycaemic status of a patient over the past two to three months, for this reasons HbA1C test has been used for diabetics follow up and diagnosis. [12]
According to a report published in 2009 by an International Expert Committee on the role of Hb A1c in the diagnosis of diabetes, Hb A1c can be used to diagnose diabetes and that the diagnosis can be made if the Hb A1c level is 6.5% or more and Hb A1c level below 6% is considered normal. [13]
Hb A1c results in the UK have usually been aligned to the assay used in the Diabetes Control and Complications Trial (DCCT), expressed as a percentage (DCCT- Hb A1c) - non-diabetic 'normal' range being 4-6%. [14]
Diagnostic criteria for diabetes that made by (World Health Organization WHO report 2011) determined that HbA1c of 6.5% was considered as the cut-off point for diagnosing diabetes. A value <6.5% does not exclude diabetes diagnosed using glucose tests. [15]
Good glycemic control around the time of conception is necessary to optimize outcome of pregnancy . The major advantage of HbA1c is the lack of impact of fluctuating glucose after meals and with illness. [16,17]
In this study, we aimed to assess the relationship between placenta weight, neonatal weight, and HbA1c in normal Sudanese pregnant ladies.

MATERIALS AND METHODS

This was a cross sectional study conducted at Alban-Jaded Teaching Hospital in Khartoum-Bahri State between October and December 2022. Alban-Jaded Teaching Hospital is a governmental secondary referral hospital located in East Nile Locality, Khartoum city which is served for approximately 980.000 citizens. It provides specialized medical and surgical facilities including obstetrics and gynecology, gastroenterology, urology, pediatrics, internal medicine and ENT.
The selection criteria were singleton delivery at term (36–42 weeks) in healthy mothers' with normal pregnancy course. The exclusion criteria included retained placenta, multiple pregnancies, placenta previa and abruptio placentae. A structured questionnaire was used for obtaining data about gestational age at delivery (in weeks), maternal age, parity, mode of delivery, birth weight, freshly delivered untrimmed placental weight, fetal gender, and presence/absence of maternal medical diseases. However, when the last menstrual period (LMP) was unknown, the gestational age was estimated via ultrasound. All placentae were weighed shortly after

delivery on a table-top beam-weighing scale together with the membranes and the cord after removing obvious blood clots. The weights of the newborn babies were recorded to the nearest gram. Weight measurements were performed using the same table-top beam weighing scale. The weight, height, and HbA1c of the mothers were measured, and their body mass indexes were calculated. The placental birth weight ratio (PBWR) was calculated as the ratio of placental weight to neonatal weight multiplied by 100. The Data was presented as mean ± SD. The significance of the difference between groups was calculated with unpaired two-tailed Student's t-tests. The chi-square test was performed to analyze the distribution of birth weights in the two groups.

Ethical consideration: Ethical Approval was obtained from the Faculty of Medicine, The National Ribat University. Also, the ethical committee of the Sudanese Ministry of Health was approved the study. Written permission was also obtained from the study setting. Verbal informed consent was obtained from each participant following explanation of the research purpose and objectives in clear, simple words. The participants had the right to withdraw at any time without any deprivation. The participant has the right to no harm (privacy and confidentiality were ensured by using a coded questionnaire). The weights of the neonates were measured by a qualified midwife; In all the procedures, the participants' wellbeing was of utmost priority. The participants had the right to benefit from the researcher's knowledge and skills. Five ml of blood sample was collected by standard technique for measurement of (HbA1c) using COPAS Integra 600 device. The remaining blood sample will not be reused for another study. Precautions for COVID-19 were taken.

Data Analysis: The data was analyzed using SPSS Software, version 25. Pearson correlation ® and t-test were used to compare the HbA1C results with placental weight. P value ≤ 0.05 was considered significant.

RESULTS

In this study, 60 pregnant ladies were included, the mean age being 27.02 ± 6.8 years (Table 1). A majority (28, 46.7%) of them were within the age group of 15–25 years. The mean BMI was 25.1 ± 3.1 (18.5–30.8); over half (31, 51.7%) of the pregnant women were overweight, and in 27 (45.0%), the BMI was normal. Regarding parity, a majority (36,60%) were para 1–3, and 14 (23.3%) were para 4–6 as shown in (Table 1).

The mean HbA1C was 5.98 ± 0.39% (5.2–6.9%). HbA1C was elevated (≥5.7%) in a majority (46, 76.7%) of pregnancies (Fig. 1).

The mean placental weight was 290 g ± 106 g (100 g–700 g), while the mean birth weight was 3.00 kg ± 0.36 kg (2.3 kg–3.8 kg), and the placental/birth weight ratio was 9.6% (Table 2).

There was a significant strong positive correlation between neonatal weight and placental weight (Cr: 0.514, P value=0.000) and also a significant strong positive correlation between neonatal and placental weight and HbA1c (Cr: 0.657, P value=0.000). There was a statistically significant association between HbA1c, neonatal birth weight (P value=0.008), and placental weight (P value= 0.004), as higher HbA1C indicated higher placental weight and higher neonatal birth weight (Table 3).

The difference in birth and placental weight between different genders (P value >0.05) was not significant, as the placenta neonatal birth weight ratio was 9.84% among females compared to 8.9% in males (Table 4). Placental weight, neonatal birth weight and PBWR significantly increased with the gestation age of neonates (P value <0.05), with a noted slight drop in term gestation. No significant correlations were reported between parity and placental weight, neonatal birth weight, and PBWR (P value >0.05). (Table 5).

Table 1: Maternal characteristics during pregnancy, including maternal age group, parity, and BMI

Age groups	Frequency	Percent
15–25	28	46.7
26–35	23	38.3
36–45	9	15.0
Maternal BMI	Frequency	Percent
Normal	27	45.0
Overweight	31	51.7
Obese	2	3.3
Parity	Frequency	Percent
1–3	36	60.0
4–6	14	23.3
6–8	9	15.0
>8	1	1.7

Table 2: Maternal descriptive characteristics (Mean ± SD)		
Variable	Mean ± SD	Range
Age (years)	27.02 ± 6.8	15–42
Maternal BMI	25.1 ± 3.1	18.5–30.8
HbA_{1c} (%)	5.98 ± 0.39	5.2 – 6.9
Birth weight (kg)	3.00 ± 0.36	2.3–3.8
Placental weight (g)	290 ± 106	100–700

Table 3: Correlation of neonatal birth weight and placental weight, and HbA1c level.			
Variable	Correlations	Pearson Correlation	Sig. (2-tailed)
Birth weight (Kg)	Placental weight (grams)	.514**	.000
	HbA1C (%)	.657**	.0008
Placental weight (grams)	HbA1C (%)	.502**	.0004
	Birth weight (Kg)	.514**	.000
**. Correlation is significant at the P value 0.01 level (2-tailed).			

Table 4: Association of neonatal birth weight and placental weight with neonatal gender and HbA_{1c} level.			
Gender	Male N= 29 (48.3%)	Female N= 31 (51.7%)	P value Independent t-test
Placental Weight (gram)	276.90 ± 95.7	302.58 ± 115.7	0.317
Birth weight (Kg)	3.09 ± 0.41	3.06 ± 0.336	0.846
PBWR ratio (%)	8.96	9.88	0.811
HbA_{1c}	<5.7 N= 14 (23.3%)	≥5.7 N= 46 (76.7%)	P value Independent t-test
Placental Weight (gram)	231.2 ± 97.2	329.74 ±100.7	0.005
Birth weight (Kg)	2.85 ± 0.34	3.150 ± 0.35	0.011
PBWR ratio (%)	8.11	10.46	0.007

Table 5: Association of neonatal birth weight and placental weight, with neonatal gestational age and parity.				
Gestational age (GA)	N (%)	Placental weight (g)	birth weight (kg)	PBWR ratio (%)
36	32 (53.3%)	282.19 ± 117	3.103 ± 0.37	9.09
37	23 (38.3%)	299.57 ± 95.0	2.98 ± 0.35	10.0
38	2 (3.3%)	235.90 ± 35.0	3.000 ± 0.30	7.86
40	1 (1.7%)	340.00 ± 0.0	3.500 ± 0.0	9.71
41	2 (3.3%)	400.00 ± 70.7	3.400 ± 0.07	11.76
P value				0.04*
Parity	N (%)	Placental weight (g)	birth weight (kg)	PBWR ratio (%)
1–3	36 (60.0)	213.61 ± 88.16	3.044 ± 0.386	7.01
4–6	14 (23.3%)	310.48 ± 129.0	3.086 ± 0.369	10.06
6–8	9 (15.0%)	405.00 ± 35.3	3.50 ± 0.14	11.57
>8	1 (1.7%)	400 ± 0.0	3.40 ± 0.0	11.76
P value				0.687

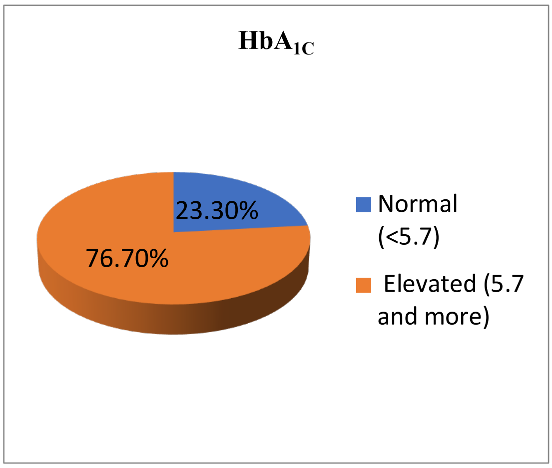

Figure 1: Maternal HbA1C level in the study

DISCUSSION

Both the placental weight and the newborn's birth weight are commonly used measurements. An effective indicator of fetal nutrition and uteroplacental function is the ratio of these two variables.[18] In this study, the mean placental weight was 290 ± 106 g (100–700 g), while the mean birth weight was 3.00 kg ± 0.36 kg (2.3 kg–3.8 kg). The placental weight observed in this study is lower than that reported in previous studies (570 g and 590 g in Italy and Nigeria, respectively,[5,19] and 588 g and 470 g in Asia and Ukraine, respectively);[20,21] in addition, much higher means have been reported: 643 g and 630 g in western Europe and eastern Nigeria, respectively.[22,23] Variances in the preparation and weighing procedures of the placenta as well as the length of time the cord was clamped may be responsible for variations in the average placental weight.[24] Additionally, it has been suggested that nutritional factors may have an impact placental weight.

In our population, the mean fetal birth weight was 3.00 kg ± 0.36 kg (2.3 kg–3.8 kg), which was also lower than 3275 g, 3425 g, 3382 g, 3036 g, and 3103 g reported in Nigeria, Ukraine, western Europe, Asia, and in the Afro-Caribbean region, respectively.[19–25] These differences in mean birth weight may be due to maternal nutrition and diseases.[19] Additionally, they may be due to the relatively small sample size used in this study.

This study showed that the placental/birth weight ratio was 9.6%, which is considered low compared to previous studies, which had values ranging from 13.9%–20%.[19–24] Furthermore, a positive correlation between the placental weight and neonatal birth weight noted in this study had also been observed by previous authors.[19–25] Additionally, the placental weight and neonatal birth weight were increased with the gestational age of neonates, with a slight decline in placental neonatal birth weight ratio at term. This is consistent with previous studies that have reported a drop in PBWR with gestational age at term.[24,27] It is assumed that an abnormally high PBWR indicates A placenta with abnormalities and reduced function (i.e., low fetal weight in comparison to placental weight).[11] On the other hand, a PBWR that is excessively low implies fetuses with presumably diminished placental reserves. Such fetuses frequently exhibit asymmetric development restriction, which may indicate that the small size of the placenta restricts ideal fetal growth.[5,28]

The current study showed that the mean HbA1C was 5.98% ± 0.39% (5.2–6.9%). The HbA1C was elevated (≥5.7%) in a majority (46, 76.7%) of pregnancies. There was a significant positive correlation between neonatal and placental weight (Cr: 0.514, P value=0.000) and between neonatal weight, placental weight, and HbA1C (Cr: 0.657, P value=0.000). Similarly, in a study by Taricco E. et al.,[5] significantly higher placental weights were reported among women with high HbA1c (N=561.87 ± 91.0 g; GDM=592.2 ± +115.8 g; P< 0.01). In line with what Strom-Roum EM, et al.[29] stated, in pregnancies with high HbA1c, the placental weight to-birthweight ratio was higher than in pregnancies with normal HbA1C, while Baptiste-Roberts K. et al.[30] found no difference in mean placental weight in diabetics as compared to non-diabetic pregnancies. Differences in ethnicity and maternal pre-pregnant obesity between women could possibly have confounded our results. These findings suggest that further studies are needed to better evaluate the effects of maternal insulin sensitivity as a determinant of placental growth and fetal outcome.

CONCLUSIONS

This study has shown a positive correlation between placental and neonatal birth weight. Additionally, HbA1C, placental weight, and neonatal birth weight are positively correlated.

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